

## SOCIAL FACTORS IN SPACE STATION INTERIORS

by

Galen Cranz, Alice Eichold, Klaus Hottes  
Kevin Jones, Linda Weinstein

Dept. of Architecture, U.C. Berkeley

Introduction

This presentation comes from the work done in a seminar on "Social Factors in Architecture" in the Department of Architecture at the University of California at Berkeley. We focused on the different theoretical perspectives which have been brought to the design of the chair. Ergonomics, production and materials, maintenance and storage, high style, historical precedent and cultural appropriateness all have their advocates as the highest priorities for chair design. We became fascinated with the problem of designing chairs for zero-gravity. Since the chair is a gravity-resisting device, it has no purpose in zero-gravity. Yet we observed chairs in Skylab and saw chairs in drawings for future interior space modules. When we asked ourselves why chairs were being implemented in outer space, the social history of the chair, which we had been studying, became relevant in a new way. The chair is a cultural artifact and institution in Western civilization, which has unquestioned value there and seems natural, almost a biological necessity. In outer space it amounts to cultural baggage.

These insights about the chair have served us as a paradigm for thinking about design processes. Accordingly, we spent time thinking about the design process for unprecedented situations, comparing and contrasting design from analogy with design for uniqueness. At the same time we confirmed the

importance of two recurrent architectural variables, flexibility and perceptual order.

### Social History of the Chair

The chair has an interesting history as an object which reveals that its real significance is as an institution. It originated some 5000 years ago in Egypt as a device for reinforcing the superior status of royalty and was copied by others as a means of dignifying themselves. Before then, people squatted, sat cross-legged, or used a variety of other postures as they do to this date in much of the Third World. Chair-sitting has become one of the distinguishing characteristics of Western civilization (Hewes 1957). Jesus did not sit, but reclined to eat at the Last Supper, as was customary at that time and in that region. (Rudofsky 1980). The Greek chair responded slightly more to anatomy than the Egyptian, with its slanted and curved back rest. Chairs disappeared during the Dark Ages and slowly re-emerged with the church hierarchy, confirming their direct relation to cultural history. Eventually in Northern Europe the domestic chair evolved from the Medieval storage chest. Only during the Renaissance did the chair come into its own as a three-dimensional object, free of the walls and room edges. Eighteenth century designers refined the prototypes, trying to balance physiology (seat-back angle, height and support of thigh versus sitbones) with the aesthetic goals of unifying the piece sculpturally (uniting arm and back transitions, leg and seat front connections, composing the back, etc.). Comfort and padding became synonymous during the 18th century when chairs were upholstered. In the 19th and 20th centuries designers started to experiment with new forms based on extending the limits of materials: laminating and

bending wood, pouring plastic into molds, expressing the tensions between steel and leather. Comfort in any sense became secondary.

Throughout these transformations, one legacy has been enduring: people sit to work. Millenia of experience and the richness of other cultures were overlooked in making the assumption that the chair was required, but the basic idea has never been seriously challenged in the West (exceptions are Gideon, 1948; Rudofsky, 1980; Caplan, 1982). We sit and lean on backrests. The result is that our torsos weaken, and we come to need the backrests. So we rely on them, and thereby need them all the more, ad infinitum in a vicious cycle. We have never seriously studied those other cultures which practice what Rudofsky calls "autonomous seating."

Consequently, when faced with a zero-gravity environment, cultural blinders kept the Skylab designers from doubting the value of the chair at the ATM work station. Chairs were drawn into the sketches and plans of work stations and built. In reality, the astronauts' experience proved that work could better be done in a "standing," neutral body posture -- that posture so remarkably close to what F. M. Alexander called the position of "mechanical advantage" which is also used in martial arts and tennis as the ready-for-anything-whatever-comes-next position.

Chair-sitting is primarily a cultural institution. We have to be trained to use chairs, but soon chair-sitting seems only natural. All children in all cultures squat comfortably, but lose that ability in the West through sustained chair-sitting. Chair-sitting produces inherent instability and leaning back against a back rest causes the body to slide forward to the point where it's slouched in a C; the chairsitter then sits up at the edge of the

chair, only to tire (because of underused, hence weakened, torsos) and then slides back to lean on the back rest, which eventually pushes the sit bones forward, and so forth in an unstable cycle.

The chair is so much a cultural given that Westerners could not recognize its liabilities and think their way free of it; those anticipating travel to space could do no better even though they were presumably trying to design free of any considerations save technical, anatomical and ergonomic.

### The Design Process

The example of the chair has alerted us to the possibility of rethinking the most basic assumptions about designing for life in space. Building on prior experience may be faulty, hence analogous situations can be of limited or even doubtful value.

The design process typically begins with a review of what is known about a subject. For example, having received a restaurant commission, an architect goes to the library to learn about the range of building types for different types of food services. If the architect has established his or her practice around restaurant design, he or she may rely on personal experience, but in either case past experience is being drawn upon, whether codified and published by others, simply remembered, or some combination of both. Ideally, the building is programmed, built, and then evaluated as to the accuracy of the designer's hypotheses about how the physical design would best fulfill the program for that type of restaurant. This evaluation would then be available for the next restaurant the firm designs and, ideally, published so that others could benefit from this experience. Ultimately, a cycle of program - design - build - evaluate - program unfolds.

In contrast to this ideal procedure, we wonder what happens to the design process when designers face a largely unprecedented situation like space stations. Analogies to similar situations of isolation, danger and confinement only provide information. Ignoring analogous situations altogether would be foolish, but drawing on them without regard for the uniqueness of the situation has led to inappropriate designs, like chairs at work stations. We propose to explore the tension between analogies and uniqueness in design process. Is it possible to anticipate all those factors which will affect the design of zero-gravity environments or must the program proceed on a trial-and-error basis, building its own post-occupancy evaluation literature? If one does not want the expense of trial and error or cannot wait for the records to accumulate, the procedure of systematic doubt offers an option which we will describe below.

#### The Question of Analogies: Or What Can 20-20 Hindsight Teach Us About Solving Design Problems?

Numerous studies of situations analogous to space stations are available. For example, in 1984 Anacapa Sciences, Inc. did a systematic comparative analysis of 13 analogs including (in descending order of relatedness): Skylab 4, Sealab II, Tektite I, Tektite II, submarines, Antarctic research stations, commercial oil field diving, long-distance yacht racing, commercial fishing vessels, research vessels (coastal), Ra Expedition, supertankers and offshore oil platforms. For each situation, they investigated how habitability affects crew productivity using 14 behavioral issues: 1. sleep, 2. clothing, 3. exercise, 4. medical support, 5. personal hygiene, 6. food preparation, 7. group interaction, 8. habitat aesthetics, 9.

outside communications, 10. recreational opportunities, 11. privacy and personal space, 12. waste disposal and management, 13. onboard training, simulation, and task preparation, and 14. behavioral and physiological requirements associated with a microgravity environment.

By this process a number of known criteria were developed for long term human adaptation to crowded interiors in hostile environments. The criteria are both physical and psychological. However useful they are, though, a second look is in order. Data gathering is not enough. For example, the incidence of insomnia increases during stressful times, precisely when rest is most crucial. Solutions to insomnia, about which very little is actually known, range from the use of drugs to increased privacy. These partial solutions are probably ancient, but the problem persists. Since more people will be spending more time in space stations, the number of cases of insomnia will certainly increase. New solutions are needed, calling on our powers of direct observation, imagination and intuition.

Soviet space station analogs are also revealing. As analogs they offer a lot of information but their greater value may be as a cross-cultural comparison which can help us question our cultural and technological assumptions. The Soviets anticipate year-round large population stations and interchangeable modules for living, working, scientific experiments. They put a great deal of emphasis on the need for comfort and amenities. They also emphasize the relationship between psychological factors and physiological functioning, as measured in tests of, for example, fatigue. Excessive leisure is as fatiguing as excessive work; a balance needs to be achieved. The Soviets reported that under conditions of prolonged isolation, subjects

occupied themselves during periods when no work was scheduled: they sang, recited poetry, read, painted, engaged in creative writing and crafts.

Cosmonauts show a leisure preference for creative and communal pleasures as contrasted with Americans who seem to prefer reading, listening to recorded music and viewing earth. Does this imply that the cosmonauts may feel less isolated from earth than the astronauts? Perhaps astronauts would enjoy interactive video games with Earth, such as chess. They might enjoy making things together, such as home movies. Humor should have an explicit role as a human need in outer space in terms of leisure design or crew selection. It is known to be therapeutic.

On the whole, the Soviets take an integrative approach. They claim that "Cosmonauts should be involved in the design. They should participate in: mockup activity, layout, development of systems in the testing laboratories and on the launch pad, participate in technical meetings to resolve problems, and help in writing and rewriting the flight plan and flight documentation."<sup>1</sup>

The work stations aboard Skylab offer a glaring example of what not to do. They were not designed to accommodate Neutral Body Posture in zero-gravity. How on earth did that happen? Just that, it happened on earth. No one imagined what the problems of Neutral Body Posture sight angles at consoles designed for chairs would really be because they were busy applying analogous scientific data and not extrapolating sensory data imaginatively.

That a chair was inserted at the Skylab workstation reinforces the postural research of Christopher Hewes which concludes that cultural influences are more important than anatomy in determining how we sit and

stand. That the astronauts tried to use it and gave up in discomfort indicates that culture can give way to circumstances.

Neutral body posture is natural when performing at a console in zero gravity. This posture has been accommodated in the latest workstation designs following the trial-and-error rather than any anticipatory design method. We are left to wonder what other features of space capsule interiors might be re-examined. Here are some possibilities:

1. The design of small things, such as drawers and doors of cabinets, should be interchangeable or modifiable.
2. Flexibility should also apply to objects like instrument placement for the psychological value of change (the simple satisfaction of rearranging the furniture) as well as for utilitarian reasons.
3. Early space stations might be designed for a select astronaut size. Small people might be the most efficient as they are as jockeys for horse racing. As more data is collected and understood, a wider range of astronaut sizes could be included.
4. Astronauts have indicated that they do not need local reference orientation; after the first few days of adaptation, they find that wherever their feet point feels like down, therefore the familiar floor is not needed and it should not be used as a frame of reference. Using it conventionally may preclude more desirable, more imaginative uses of walls and ceilings for spatial variety and utility.
5. Has a preference for symmetry vs. asymmetry been established for either functional or aesthetic reasons or both?



6. Is the table the most logical place to eat and work on things in zero-gravity?
7. Would bicycle seats on flexible and vertically adjustable stems (perhaps with knee activated leg restraints) function well in lieu of chairs?
8. Do people need to relate across body axes, such as the vertical axis through the body and the horizontal axis between the eyes or can people's bodies be tilted to one another and still work well together?
9. What are ways that humor can make a group more cohesive? How can the design of the interior accommodate or reflect this?
10. What possibilities for training exercises (such as ocean sailing) might prepare crews for media publicity as well as encourage group cohesiveness under stress?
11. In what ways are anthropometric measures important in a microgravity environment?
12. Many of these concerns might best be addressed by astronauts themselves, and their experience integrated into the design process following the architect-client relationship. The program would then emerge from an analysis of the user's needs and constraints. Once developed, the client and designer would agree to follow the program. Thereafter, design assumptions may be made and challenged. For example, having agreed on the need for two square feet for a task, the assigned area could be square, rectangular, or round and each shape could be challenged.

What can we learn from analogies? We know we can learn some things not to repeat, but can we avoid unprecedented mistakes in the first place? How can a designer do that? Certainly, not all mistakes can be avoided or should be

avoided given what we learn from them, but how can a designer avoid getting off on the wrong foot and establishing precedents that may be difficult to change? We propose using intuition and imagination coupled with experience in applying what is already known and then challenging the results. Once made, an assumption should always be challenged.

A designer may apply known criteria to an old solution that has been tried before, using a great deal of intuition and imagination or very little. And a designer may apply known criteria towards a new solution utilizing a great deal of intuition and imagination or very little. One or another or all solutions may prove to be appropriate. How is one to know? Doubting may be the best means of challenging assumptions; self-doubt could be the best safety net.

Professor Horst Rittel at U.C. Berkeley, an international authority in design methods, has developed the principle of systematic doubt. A problem is stated and then every word is systematically negated in turn. The systematic reversal of different components of the "reality" in the original statement offers different opportunities for intervention, questions which might be overlooked otherwise. One example of how our seminar applied his method to the design of space station interiors is the following assumption and its reversals:

ASSUMPTION: The unprecedented conditions of long term living, i.e. work and leisure, in zero-g requires unprecedented interior design solutions in lieu of chairs -- such as restraining devices which may be flexible or rigid. We then challenged each part of that assumption.

1. There are no unprecedented conditions:

- there are precedents such as Skylab and restraint was not a big issue;
- there are no all female or mixed crew precedents;
- 90 days is not long term;
- 90 days in zero-g is long term; human factors come into play.

2. Living in zero-g on a space station does not include work and leisure:

- it is not living; it is confinement;
- it is not living; it is all work, all mission; the same is true for submariners and fire fighters;
- it is leisure, just as life on a camping trip is leisure when one is always working;
- it is not working; astronauts are having the time of their lives; lots of people would give anything for a space flight;
- it is working, whether enjoyed or not; astronauts have enormous responsibility all of the time;
- everyone is responsible for each other's lives, all of the time, just like mothers of infants;
- everyone needs time off, time to not be responsible; it might be a good idea to give everyone time off from emergency responsibility; although they may not take it should an emergency arise, it might help them to enjoy leisure more.

3. In zero-g there are no unprecedented interior design solutions:

- we build on things we know; there are no unprecedented solutions;
- it is theoretically possible to have unprecedented solutions;
- there is no totally innovative solution; nothing comes from out of the blue.

4. In lieu of chairs, restraining devices need not be rigid or flexible:
- restraint is needed for certain tasks: to supply resistance,  
to aid manual dexterity, to facilitate sleeping;
  - restraint could be comforting if not physically needed;
  - restraint could be uncomfortable, yet needed;
  - there are both physiological and psychological reasons for needing and  
not needing restraining devices depending on the task;
  - rigid is preferred for working;
  - flexible restraints are best for sleeping;
  - flexible restraint implies that the user has a flexible radius and  
rigid implies a fixed radius.

Designing for Uniqueness: United Nations vs. Camp David

When designing for a unique or unprecedented situation this method surpasses reliance on analogy. Used alone, analogies may blind us at worst or at best provide insufficient information. The space station is a special environment, a unique one with potential for new social relations which can promote (or hinder) international cooperation. There is a range of other special environments for international negotiations, all the way from the urban formality of the United Nations to the rustic informality of Camp David. The United Nations General Assembly and Headquarters in New York is one of the most unique working environments to be designed during this century. As an organ specifically charged with the responsibility of maintaining, or better yet, attaining peace and conflict resolution at the international level, it functions as no other.

As one would expect, teams of the finest architects, engineers, planners

and other professionals were selected to create the environment that would house the organs of the U.N. The representative architect of France, Le Corbusier, describes the responsibility of the designers of this most ambitious project: "It is truly worthwhile to seek and discover the elements by which this problem can be more closely examined."<sup>2</sup>

In the long run, though, the formal environment of the U.N. had to be supplemented by a network of less formal offices and meeting places in apartments and hotels. The formal sector overlooks the many different cultures that work there. The United Nations complex is one model of how to facilitate the communication, mutual respect, and sense of shared mission, and clear conflict resolution needed to attain and maintain world peace that need to take place under its roofs. The U.N. is not limited because of the environment alone, but any successes, as architectural historian Lewis Mumford puts it, "... will be in spite of, not because of the architecture ..."<sup>3</sup>

Site selection became moot for the U.N. designers when land was granted to them by the Rockefellers. Perhaps they "jumped the gun"; not having had to decide where to locate the buildings meant they did not have to align purpose with place. In any case, in setting about to create a program to design the "complex," the designers skipped over the issue of defining goals and went straight to specific and known analogous situations.

For example, negotiations and council meetings were analyzed for what they have in common with business meetings, the corporate workplace and its organizational structure. While we would not dispute the necessity of looking to the business world to help draw analogies, this overlooks the greater picture of group meetings in general. It also perpetuates certain presumed

givens, which could have been doubted: Are all the delegates and workers who will occupy the space of the U.N. accustomed to sitting in Western-type chairs? Would people coming together to resolve world problems have to carry along a staff structured in much the same way as a corporation? Is a high rise office tower the only form which can accommodate a large number of people working closely together?

No program was developed for the design of the United Nations complexes, but, a "Summary of Requirements of the United Nations" was formulated instead. The basis of that summary was a questionnaire answered by the Secretariat, the administrative arm of the U.N. The questionnaire focused on what were the eleven considerations of design: The Assembly, the Economic and Social Council, the Trusteeship Council, specialized agencies, The Secretariat, the library, restaurants, the National Delegation, living and communications.<sup>4</sup>

This narrow focus created a one dimensional space allocation program. The problem was reduced to area tabulations. What was overlooked is that this was supposed to be a unique environment with a unique working etiquette, unique cross cultural interactions, unique people with a unique mission; it is instead a lost opportunity.

In contrast, Camp David is an example of a unique situation that has been programmed for more informal negotiations. Camp David was the place for a Mid-East Summit. Although the Camp David talks were between Sadat, Begin and Carter, they were not limited to those three men. Hundreds of support personnel and negotiators were present and played an active role in the peace process.

Jimmy Carter, his wife and staff must have found themselves in a similar situation as the designers of the U.N. They had no precedent for an environmental program for conflict resolution. Like outer space, Camp David was a special place where special things could occur. What strikes us is how carefully the Carters and their staff managed the micro-environment, sight lines and pathways. Every detail was forged to serve their ultimate guiding purpose of the environment. Paul Frankl describes the role of environmental design in fulfilling purpose in Principles of Architectural History:

... architecture forms the fixed arena for actions of specific duration, that it provides the path for a definite sequence of events ... the principal and secondary passages existing within each space have their logic. The clearly prescribed circulation, which leads us through the different spaces in an opera house, through the vestibule to the ticket office, or through the corridors and up steps to a cloakroom, presupposes a definitely ordered activity, and the spatial form is completely dependent upon the particular type of activity.<sup>5</sup>

In developing their program, the Carters' first priority in designing the environment reflected the highest priority of the Summit: to reach an accord. Hence the environment's most important function was to facilitate that accord. For the Carters always keeping the big picture in mind simplified the resolution of many other facets of the design; from the importance of accommodating prayer, a five-times-a-day ritual for most of the Egyptian delegation, to special food handling and preparation for the majority of the Israeli delegation which kept kosher.

The entire temporal as well as spatial environment was altered to help bridge the relations of the two different and opposing groups by providing for their specific needs and providing cues that helped each side perceive the common ground that it shared with the other. Attention was paid to when and

where people would cross paths, whether they would be alone or with company during times of contemplation and what environment would be best for each of these purposes. Cues were provided that allowed them to see what they had in common; a photograph of an adversary's child, movies which would be enjoyed by both sides. These cues gave the participants the opportunity to see one another as fellow human beings; the love of one's children could not be denied.<sup>6</sup>

Since in the future space stations are likely to be manned by astronauts from several different nations, we suggest additional research and study of all the settings which have been designed especially for international negotiations and cooperation.

### Flexibility and Order

Unique problems must be accommodated when designing a unique environment. We will learn the most about the needs of the space station environment after it has been placed in orbit, after teams of astronauts live in it. More than likely, we will need to make changes in the space station, so designing for change becomes a central design goal.

Three basic ways to deal with change are possible. One might construct a whole new space station and place it in another orbit, but this method would be costly in terms of money and resources -- and leaves the problem of the old space station. Retrofit -- or remodeling as we call it in architecture -- could be a way to accommodate changes, but that too would be costly and presents a whole new set of problems. A third approach is designing flexibility into the environment. Thus, the space station could be designed



with changes in mind. Post occupancy evaluation and improved programming merge in the physical design itself.

Flexibility emerges as one of the general goals for the physical form of the space station interior. Another general goal has emerged from our observations -- the need for perceptual order. Flexibility and order might seem contradictory but they are not. The need for order is real, but the type of order might vary as the sub-culture of the group or even the international and global purposes of the entire enterprise evolve. Thus the same arguments against starting over with unchangeable and abandonable stations or expensive retrofitting apply regarding spatial order.

#### Why Be Concerned with Perceptual Order?

We are continually engaged in making sense out of the world around us. We have built defenses against the absurd in the human condition and at the same time developed a scheme that will make possible reasonably accurate predictions of the behavior of others. Although some of us may tolerate doubt, few can tolerate meaninglessness. To survive psychically, we must conceive a world that is fairly stable, relatively free of ambiguity, and reasonably predictable. Some structure must be placed on the flow of impressions: events must be viewed from some perspective. We look at the world through mental patterns or templates which we create and attempt to fit over the realities of the world. The fit is not always good. But without patterns the world appears to be such an undifferentiated homogeneity that we are unable to make any sense out of it. (Barnlund, 1968)

We recommend that the functional arrangement of the module's interior be reinforced by a visual organizational pattern. This would help reduce the

sense of instrument clutter and visual discord frequently seen in spacecraft interiors. (See Figure .)

The manipulation of various textures can be used to establish a clear visual order in interiors. Particular elements of the interior can be emphasized while others can be played down. Color can be used in a consistent manner. Subtle or pronounced changes in color, or texture, can organize the environment. Light can be manipulated as well. For example, the gradation of light through a space can layer the interior into distinct areas, or reflected light off of a wall or ceiling can emphasize a plane. Light, more so than color or texture, is extremely flexible. It can be easily directed to highlight different surfaces. In addition, the intensity of light can be varied to greatly alter our perception of spaces. These elements, texture, light and color, can be orchestrated to produce a recognizable gestalt.

The typical office building offers a familiar example. The particular functional arrangement of space is reinforced by textural layers that provide psychological cues. The simple change from the cold, concrete sidewalk and steps to the warm terrazo and then carpet signals us to adjust our behavior and attitudes accordingly. At times, these cues are totally subliminal, yet they affect our behavior and attitude constantly.

#### The Transition between Personal Space and Workspace

We desire and seek out communication with others. Each of us has personal needs that can only be satisfied by interaction with others. We also need to control our environment, and regulate social contacts. Privacy is required by all of us. Many of the familiar methods of privacy maintenance are not possible in limited spacecraft interiors. The restricted physical

space leads to forced interactions and increases the probability that the individuals will feel a lack of privacy. This has led to aggressive behavior or withdrawal from others. The habitation module should provide relief from constant overstimulation, afford privacy, and individual control.

Sleeping spaces, if designed correctly, can provide the desired sense of control and privacy. Personalization of sleeping quarters should be stressed, along with the opportunity to associate with others in various degrees. Flexible association with others is important. Sometimes, these quarters may serve as a semi-private zone for two. With volume being at a premium, these spaces must be designed not solely for sleeping, but also for personal expression, privacy, and territorial control. Unless these basic issues appear on the initial agenda, they will probably not be applied in the final design.

In the workspace, the activities and presence of others can be as imposing and distracting as in other areas. The same needs for control and flexibility should be stressed even more rigorously since the individual cannot dictate the activities of others. Our need for space expands and contracts depending on the activity performed and the level of stress we experience. Work space should be designed to allow for this fluctuation. Working may be very social. A flexible design can reinforce the pleasure of working and being together and adapt to more private work at other times. Here lighting could be crucial, flooding a central space on the social occasions while lighting individual workstations at the perimeter of the same space during private work phases. The need for flexibility within a perceptually ordered system emerges yet again.

We cannot focus on the design of a personal space or social workspace alone. The elements that link, or overlap, spaces are as important as the individual spaces themselves. We are universally accustomed to transitional elements that denote the gradation from the public to private realm. Establishing a network of transitional elements is especially important since distance and volume are restricted. Although walls work as boundaries, their function as screening devices may be much more efficiently and flexibly achieved by using color, light, and texture. These elements, when combined in unison or opposition, create powerful, yet flexible, transitions when considered in the context of a small space capsule.

We suspect that a spiral organization of volume may offer the best definition of separate areas without sacrificing the maximum perception of the whole interior or wasting space on dividers. Such a baroque form could provide a perception of greater space since something would be around a bend, without losing a feeling of largeness.

### Conclusion

Given the example of the chair, our difficulty in freeing ourselves of cultural assumptions is remarkable. Therefore, we call for an experimental approach which would allow designers to separate cultural assumptions from logistic, social and psychological necessities. Simulations, systematic doubt and monitored brainstorming should be included as a part of basic research so that the designer approaches the problems of space module design with a full and complete program. A complete program represents a well-defined problem and a well-defined problem is already on its way to becoming a solution.

ANNOTATED BIBLIOGRAPHY ON AEROSPACE by Alice Eichold

Ames Research Center, Living Aloft: Human Requirements for Extended Spaceflight, (NASA, Moffett Field, 1985).

a study of physical and psychological design parameters

Bodde, Tineke, "The Body's Answer to Zero Gravity," BioScience, Apr., 1982, p. 249.

metabolic changes and osteoporosis

Boeing Aerospace Co., Space Station/Nuclear Submarine Analogs, (National Behavior Systems, Granada Hills, 1983).

an examination of the working and leisure facilities for crew of nuclear submarines including procedures, equipment and psycho-social factors

Boeing Aerospace Co., Space Station/Soviet Space Station Analog, (National Behavior Systems, Granada Hills, 1983).

chapter headings: 1. Environment, 2. Extra Vehicular Activity, 3. Organization Systems, 4. Personality Systems, 5. Physical Condition of the Cosmonaut

Brookman, Denise C., "The Manned Space Station: Halfway House to the Stars," Design News, Sept. 9, 1985.

the manned space station for civilian-oriented tasks may have military uses as well

Cohen, Marc M. and Rosenberg, Erika, Proceedings of the Seminar on Space Station Human Productivity, (NASA, Moffett Field, 1985).

seminar minutes: both design configuration and mission functions are considered

Cohen, Marc M., Human Factors in Space Station Architecture 1: Space Station Program Implications for Human Factors Research, (NASA, Moffett Field, 1985).

four premises pertaining to launch, orbit, power supply and microgravity shape the entire space station program

Douglas, William K., M.D., Human Performance Issues Arising from Manned Space Station Missions, (NASA, Moffett Field, Nov., 1985).

interviews with ten former NASA astronauts discussing thoughts, opinions, conclusions or suggestions which might have evolved since they left the astronaut program

Gorman, James, "Righteous Stuff," Omni, May, 1983, p. 46.

astronaut consciousness of religion and metaphysics

Griffin, Brand Norman, Design Guide: The Influence of Zero-G and Acceleration on the Human Factors of Spacecraft Design, (NASA, Houston, 1978).  
reference for zero-g anthropometrics

Haines, Richard F., Space Station Interior Design: Results of the NASA/AIA Space Station Interior National Design Competition, (NASA, Moffett Field, 1975).

history of and some entries from the competition with guidelines and constraints

Johnson Space Center, Space Station Program Phase B Kick Off Meeting, (NASA, Houston, 1985).

a program overview for a one day meeting concerned with aspects of management and engineering emphasized

Johnson Space Center, Skylab Experience Bulletin No. 17: Neutral Body Posture in Zero-G, (NASA, Houston, 1975).

an examination of the impact of Skylab's having been designed as though for one-gravity with recommendations that the space station be designed for zero-gravity human factors

Joyce, Christopher, "Space Travel Is No Joyride," Psychology Today, May, 1984, p. 30.

behavioral methods may alleviate some of the discomfort that accompanies weightlessness

O'Neill, Gerard K., "The New American Frontier," Discover, Nov. 1985, p. 70.  
design ideas for large industrial colonies and factories in space with an emphasis on cost effectiveness

Overbye, Dennis, "Success Amid the Snafus," Discover, Nov. 1985, p. 52.  
an investigation of research projects planned for or executed by the space shuttle or the give and take between flown and gown

Raasch, R. F., Peercy, R. L. Jr. and Rockoff, L. A., Space Station Crew Safety: Alternatives Study -- Final Report, (Rockwell International, Downey, 1985).

assesses risks and aggregates released data that has been in preparation by the aerospace community since 1968

Roland, Alex, "Triumph or Turkey," Discover, Nov. 1985, p. 26.

the story of NASA requesting a re-usable space craft for servicing space stations as early as 1969 and impact of the price tag determined by Congress and the Office of Management and Budget (then directed by Casper Weinberger) on the outcome

Space Craft Design Division, Crew Station Specifications, (NASA, Houston, 1982).

specifications for crew station design and operations

Stokes, J. W., Man/System Requirements for Weightless Environments, (NASA, Huntsville, 1976).

reference guidelines, constraints and criteria for developing manned orbiting payloads with none of the illustrations reflecting zero-g neutral body posture

Stuster, Jack W., Ph.D., Space Station Habitability Recommendations Based on a Systematic Comparative Analysis of Analogous Conditions, Anacapa Sciences Inc., Santa Barbara, 1984).

14 behavioral issues identified and examined for conditions such as: Sensory Deprivation, Antarctic Research Stations, Remote Military Outposts, Nuclear Submarines, Undersea Habitats

Systems Engineering and Integration Space Station Program Office, Space Station Reference Configuration Description, (NASA, Lyndon B. Johnson Space Center, Houston, Aug. 1984).

configuration of the Grumman Power Tower including descriptions of all major systems

Tanner, Trieve and Cohen, Marc, Concept Development Group: Space Station, Habitability Module Considerations, (NASA, Moffett Field, 1983).

predesign studies including module configuration and contingency factor identification covering: volume, sleep, privacy, galley, wardroom, exercise, personal hygiene and radiation shelter

Taylor, Thomas C., Space Station Architectural Elements Model Study, (NASA, Moffett Field, 1985).

studies of design options for a central beam configuration of the module interior

Wortz, E. C. and Gafvert, M. R., Proceedings, 28th Annual Conference, California Council, the American Institute of Architects, Nov. 24, 1973.

habitability: perceived quality of life as defined by a group of nine architects

BIBLIOGRAPHY ON UNITED NATIONS by Linda Weinstein

Frankl, Paul, Principle of Architectural History (1968).

Mumford, Lewis, "United Nations Assembly," New Yorker Magazine, (1953).

Falk, Richard, "The United Nations After 40 Years," The Nation, Sept. 21, 1985.

Bourdet, Claude, "The U.N. Revisited: The Soul of the 'Machine,'" The Nation.

Harrison, Wallace K., "The U.N. Building in N.Y." Transcript of Director's presentation before the RIBA, RIBA Journal, February 20, 1951.

Rudolph, Paul, "U.N. General Assembly," Architectural Forum. October 1952.

\_\_\_\_\_, "Planning for Peace," Architectural Record, April 1947.

Beres, Louis Rene and Torg, Harry R., Planning Alternative World Futures, Values, Methods & Models, (1975).

Carter, Roslyn, First Lady from Plains, (1984).

Hall, Peter, Great Planning Disasters, (1980).

\_\_\_\_\_, "The U.N.," The Builder, Feb. 23, 1951.

\_\_\_\_\_, "Six Recent Buildings in the U.S.A.: U.N. Headquarters, N.Y.," The Architects Yearbook, VS 1953, p. 133-169.

\_\_\_\_\_, "Permanent Headquarters, New York for the U.N.," The Builder, August 15, 1947.

\_\_\_\_\_, "N.Y. Proposes a World Capitol for the U.N.," Architectural Forum, November 1946.

\_\_\_\_\_, "The New General Assembly Building in N.Y.," Arch. and Building News, October 16, 1952.

\_\_\_\_\_, "U.N. General Assembly Meets a Complex Plan Problem with the 'Visual Poetry' of an Elegant Concave Shape," Architectural Forum, May 1950.

General Assembly Headquarters Advisory Committee, Planning the Permanent Headquarters of the U.N.: A Short Summary, (1948).

Jeanneret-Gris, Charles Edouard, U.N. Headquarters, (1947).



U.N. Headquarters Commission, Report to 2nd Part of 1st Session of the General Assembly of the U.N., (1946).

Friedlander, Melvin, Sadat and Begin: the Domestic Politics of Peacemaking, (1983).

Carter, Jimmy, Keeping Faith: Memoirs of a President, (1982).

#### FOOTNOTES

1. Boeing Aerospace Company, Space Station/Soviet Space Station Analog, October 1983, p. 203.
2. Jeanneret-Gris, Charles Edourd, UN Headquarters, 1947, p. 2.
3. Mumford, Lewis, "United Nations Assembly," 1953, New Yorker Magazine, pp. 108-110.
4. Report to the 2nd Part of the First Session of the General Assembly of the U.N., U.N. Headquarters Commission, 1946.
5. Frankl, Paul, Principles of Architectural History, 1968, pp. 157-8.
6. Carter, Roslyn, First Lady from Plains, 1984.